

# NOA Sixth Form



## Physics

### Bridging Work 2023

To support you in your transition into sixth form and onto A Level/Level 3 courses, it is important you are prepared for this transition. Bridging work will help prepare you for the start of sixth form and allow you to see what this work may be like.

All work will need to be physically handed into teachers in your **first lesson** in September.  
Online submission dates are detailed below.

If you have any questions regarding the work, please email the teacher below.

**Alex West – Physics Teacher**

[Alex.west@northoxfordshire-academy.org](mailto:Alex.west@northoxfordshire-academy.org)

# A LEVEL PHYSICS

2022-2024

Welcome to Physics! I hope you are looking forward to focussing on those subjects which you found most interesting and most enjoyable at GCSE. Many people think that physics is hard, but we know better. So long as you love maths (particularly algebra!), aren't concerned about working with the Greek alphabet and can appreciate both the infinite nature of space and the beautiful uncertainties of the quantum realm, we're going to have a great two years.

It is essential that you use this summer to remove any worries which you might have had within the GCSE curriculum so that we can start building on your knowledge as soon as we get back in September. Your lessons throughout the year have helped you to lay the foundation for A Level, but it is particularly important that you work independently to ensure you are well prepared for the start of the A Level course.

Remember, you are completing this work for you, not for me. Don't rush it just to get it done (that would be pointless) or to avoid trouble. Complete the work with the aim of **learning** from it. If you don't understand something, spend extra time working on it. If you are interested in something, research it further by finding further reading on the subject, watching a video about it or listening to a podcast. Your effort will pay off.

A-levels aren't simply about learning more facts, but also about developing critical thinking skills and deep understanding around the subject. When you are completing these tasks, particularly Task 2, think carefully and critically about your work and the questions being asked. Ensure that the summaries that you make are fully explained and use scientific language.

There are some good transition textbooks around to further help your A level preparations. Working through these books would be in addition to any other transition work as below, but I would certainly recommend it, particularly if your GCSE grade expectations are not high. If you do complete this work, please keep your working out organised as I might ask to see it.

<https://www.cgpbooks.co.uk/secondary-books/as-and-a-level/science/physics/pbr72-head-start-to-a-level-physics-with-online-e>

<https://www.cgpbooks.co.uk/secondary-books/as-and-a-level/science/physics/pmr71-a-level-physics-essential-maths-skills>

**Both Task 1 and Task 2 should be physically handed in at the start of our first lesson in September.**

### **Task 1 – Suggested completion date – Monday 31<sup>st</sup> July 2023 (5 hrs)**

Firstly, spend three to four hours completing the content below. Write out just the answers on paper, being careful to number each topic and question within the topic. Show full working out. Break it up over at least three different days! Each topic should take around 10 to 15 minutes to work through. Look for help in the CGP books above, BBC Bitesize, studyrocket etc. or email me if you are stuck.

Secondly, once you have done as much as you can, **e-mail the work to me** at [alex.west@northoxfordshire-academy.org](mailto:alex.west@northoxfordshire-academy.org). This is probably done most easily by photographing your written work. Suggested completion date – **Monday 31<sup>st</sup> July**. Last possible date to send this is **Thursday 31<sup>st</sup> August**. I will then send you the mark scheme.

Next, mark the work thoroughly and **self-assess** as below. It is vitally important that you are aware of your strengths and weaknesses – only then can you tackle those weaknesses in a systematic way and so improve your overall capability.

Finally, **bring the marked work and the feedback grid into school ready for the first physics lesson of the year.**

### **Task 2 – Suggested completion date – Monday 28<sup>th</sup> August (5 hrs)**

Details are at the end of Task 1.

### **Further Reading – suggested completion at any time during the summer (5 hrs)**

Details are at the end of Task 2.

# Task 1 contents

Topic	Title	Completed (date)	Comments. Do you need more practice? Are you confident with this area? What areas of weakness have you identified?
1	Prefixes and units		
2	Significant Figures		
3	Converting Length, Area and Volume		
4	Rearranging Equations		
5	Variables		
6	Constructing Tables		
7	Drawing Lines of Best Fit		
8	Calculating Gradients – Straight Lines		
9	Calculating Gradients – Curved Lines		
10	Calculating Areas – Straight Line Graphs		
11	Calculating Areas – Curved Line Graphs		
12	Interpreting Graphs		
13	Accuracy vs Precision		
14	Identifying Errors		
15	Improving Experiments – Accuracy, Precision and Reliability		

Physics	1. Prefixes and units
Skills	

*In Physics we have to deal with quantities from the very large to the very small. A prefix is something that goes in front of a unit and acts as a multiplier. This sheet will give you practice at converting figures between prefixes.*

Symbol	Name	What it means		How to convert	
P	peta	$10^{15}$	1000000000000000		↓ x1000
T	tera	$10^{12}$	1000000000000	↑ ÷ 1000	↓ x1000
G	giga	$10^9$	1000000000	↑ ÷ 1000	↓ x1000
M	mega	$10^6$	1000000	↑ ÷ 1000	↓ x1000
k	kilo	$10^3$	1000	↑ ÷ 1000	↓ x1000
			1	↑ ÷ 1000	↓ x1000
m	milli	$10^{-3}$	0.001	↑ ÷ 1000	↓ x1000
μ	micro	$10^{-6}$	0.000001	↑ ÷ 1000	↓ x1000
n	nano	$10^{-9}$	0.000000001	↑ ÷ 1000	↓ x1000
p	pico	$10^{-12}$	0.000000000001	↑ ÷ 1000	↓ x1000
f	femto	$10^{-15}$	0.000000000000001	↑ ÷ 1000	

Convert the figures into the units required.

6 km	=	6 x 10 <sup>3</sup>	m
54 MN	=		N
0.086 μV	=		V
753 GPa	=		Pa
23.87 mm/s	=		m/s

Convert these figures to suitable prefixed units.

640	GV	=	640 x 10 <sup>9</sup> V
		=	0.5 x 10 <sup>-6</sup> A
		=	93.09 x 10 <sup>9</sup> m
	kN	=	32 x 10 <sup>5</sup> N
	nm	=	0.024 x 10 <sup>-7</sup> m

Convert the figures into the prefixes required.

s	ms	μs	ns	ps
0.00045	0.45	450	450 000 or 450 x 10 <sup>3</sup>	450 x 10 <sup>6</sup>
0.000000789				
0.000 000 000 64				

mm	m	km	μm	Mm
1287360				
295				

The equation for wave speed is:

$$\begin{array}{ccccc} \textit{wave speed} & = & \textit{frequency} & \times & \textit{wavelength} \\ (m/s) & & (Hz) & & (m) \end{array}$$

Whenever this equation is used, the quantities must be in the units stated above. At GCSE we accepted m/s but at AS/A Level we use the index notation. m/s becomes  $m s^{-1}$  and  $m/s^2$  becomes  $m s^{-2}$ .

By convention we should also leave one space between values and units. 10m should be 10 m.

We also leave a space between different units but no space between a prefix and units.

This is to remove ambiguity when reading values.

Example  $ms^{-1}$  means 1/millisecond because the ms means millisecond,  $10^{-3}$  s

but  $m s^{-1}$  means metre per second the SI unit for speed.

or  $mms^{-1}$  could mean  $mm s^{-1}$  compared with  $m ms^{-1}$   
millimetres per second compared with metres per millisecond - quite a difference!!!

Calculate the following quantities using the above equation, giving answers in the required units.

- 1) Calculate the speed in  $m s^{-1}$  of a wave with a frequency of 75 THz and a wavelength 4.0  $\mu m$ .

$$v = f \lambda = 75 \times 10^{12} \times 4.0 \times 10^{-6} = 3.0 \times 10^8 \text{ m s}^{-1} \text{ (300 Mm s}^{-1}\text{)}$$

- 2) Calculate the speed of a wave in  $m s^{-1}$  which has a wavelength of 5.6 mm and frequency of 0.25 MHz.

- 3) Calculate the wavelength in metres of a wave travelling at 0.33  $km s^{-1}$  with a frequency of 3.0 GHz.

- 4) Calculate the frequency in Hz of a wave travelling at  $300 \times 10^3 \text{ km s}^{-1}$  with a wavelength of 0.050 mm.

- 5) Calculate the frequency in GHz of a wave travelling at  $300 \text{ Mm s}^{-1}$  that has a wavelength of 6.0 cm.

Physics	2. Significant Figures
Skills	

1. **All non-zero numbers ARE significant.** The number 33.2 has THREE significant figures because all of the digits present are non-zero.

2. **Zeros between two non-zero digits ARE significant.** 2051 has FOUR significant figures. The zero is between 2 and 5

3. **Leading zeros are NOT significant.** They're nothing more than "place holders." The number 0.54 has only TWO significant figures. 0.0032 also has TWO significant figures. All of the zeros are leading.

4. **Trailing zeros when a decimal is shown ARE significant.** There are FOUR significant figures in 92.00 and there are FOUR significant figures in 230.0.

5. **Trailing zeros in a whole number with no decimal shown are NOT significant.** Writing just "540" indicates that the zero is NOT significant, and there are only TWO significant figures in this value.

**(THIS CAN CAUSE PROBLEMS!!! We should use standard form for clarity, but often don't - e.g.  $500/260 = 1.9$  to 2 sf. Better  $5.0 \times 10^2 / 2.6 \times 10^2 = 1.9$ )**

8. **For a number in scientific notation:  $N \times 10^x$ , all digits comprising N ARE significant by the first 5 rules; "10" and "x" are NOT significant.**  $5.02 \times 10^4$  has THREE significant figures.

*For each value state how many significant figures it is stated to.*

Value	Sig Figs	Value	Sig Figs	Value	Sig Figs	Value	Sig Figs
2		1066		1800.45		0.070	
2.0		82.42		$2.483 \times 10^4$		69324.8	
500		750000		0.0006		0.0063	
0.136		310		5906.4291		$9.81 \times 10^4$	
0.0300		$3.10 \times 10^4$		200000		40000.00	
54.1		$3.1 \times 10^2$		12.711		$0.0004 \times 10^4$	

**When adding or subtracting numbers**

Round the final answer to the **least precise** number of decimal places in the original values.

E.g.  $0.88 + 10.2 - 5.776 (= 5.304) = \underline{5.3}$  (to 1d.p. , since 10.2 only contains 1 decimal place)

(Khan Academy- Addition/ subtraction with sig fig excellent video- make sure you watch .)

*Add the values below then write the answer to the appropriate number of significant figures*

Value 1	Value 2	Value 3	Total Value	Total to correct sig figs
51.4	1.67	3.23		
7146	-32.54	12.8		
20.8	18.72	0.851		
1.4693	10.18	-1.062		
9.07	0.56	3.14		
739762	26017	2.058		
8.15	0.002	106		
152	0.8	0.55		

### When multiplying or dividing numbers

Round the final answer to the **least** number of significant figures found in the initial values.

E.g.  $4.02 \times 3.1 \mid 0.114 = (109.315\dots) = \mathbf{110}$  (to 2s.f. as 3.1 only has 2 significant figures).

*Multiply the values below then write the answer to the appropriate number of significant figures*

Value 1	Value 2	Total Value	Total to correct sig figs
0.91	1.23		
8.764	7.63		
2.6	31.7		
937	40.01		
0.722	634.23		

*Divide value 1 by value 2 then write the answer to the appropriate number of significant figures*

Value 1	Value 2	Total Value	Total to correct sig figs
5.3	748		
3781	6.50		
$91 \times 10^2$	180		
5.56	$22 \times 10^{-3}$		
3.142	8.314		

### When calculating a mean

- 1) Remove any **obvious** anomalies (circle these in the table)
- 2) Calculate the mean with the remaining values, and record this to the **least** number of decimal places in the included values

E.g. Average 8.0, 10.00 and 145.60:

- 1) Remove 145.60
- 2) The average of 8.0 and 10.00 is **9.0** (to 1 d.p.)

*Calculate the mean of the values below then write the answer to the appropriate number of significant figures*

Value 1	Value 2	Value 3	Mean Value	Mean to correct sig figs
1	1	2		
435	299	437		
5.00	6.0	29.50		
5.038	4.925	4.900		
720.00	728.0	725		
0.00040	0.00039	0.000380		
31	30.314	29.7		



# 3. Converting length, area and volume

Whenever substituting quantities into an equation, you must always do this in SI units – such as time in seconds, mass in kilograms, distance in metres...

If the question doesn't give you the quantity in the correct units, you should always convert the units **first**, rather than at the end. Sometimes the question may give you an area in  $\text{mm}^2$  or a volume in  $\text{cm}^3$ , and you will need to convert these into  $\text{m}^2$  and  $\text{m}^3$  respectively before using an equation.

To do this, you first need to know your length conversions:

$$1\text{m} = 100\text{ cm} = 1000\text{ mm} \quad (1\text{ cm} = 10\text{ mm})$$

$\text{m} \rightarrow \text{cm}$	$\times 100$	$\text{cm} \rightarrow \text{m}$	$\div 100$
$\text{m} \rightarrow \text{mm}$	$\times 1000$	$\text{m} \rightarrow \text{mm}$	$\div 1000$

Always think –

*“Should my number be getting larger or smaller?” This will make it easier to decide whether to multiply or divide.*

## Converting Areas

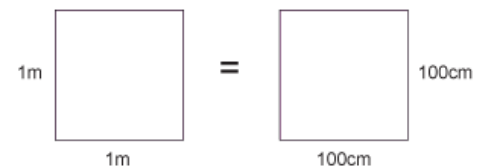
A  $1\text{m} \times 1\text{m}$  square is equivalent to a  $100\text{ cm} \times 100\text{ cm}$  square.

Therefore,  $1\text{ m}^2 = 10\,000\text{ cm}^2$

Similarly, this is equivalent to a  $1000\text{ mm} \times 1000\text{ mm}$  square;

So,  $1\text{ m}^2 = 1\,000\,000\text{ mm}^2$

$\text{m}^2 \rightarrow \text{cm}^2$	$\times 10\,000$	$\text{cm}^2 \rightarrow \text{m}^2$	$\div 10\,000$
$\text{m}^2 \rightarrow \text{mm}^2$	$\times 1\,000\,000$	$\text{m}^2 \rightarrow \text{mm}^2$	$\div 1\,000\,000$



## Converting Volumes

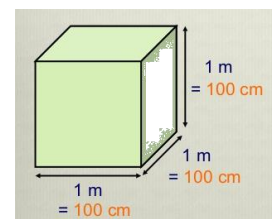
A  $1\text{m} \times 1\text{m} \times 1\text{m}$  cube is equivalent to a  $100\text{ cm} \times 100\text{ cm} \times 100\text{ cm}$  cube.

Therefore,  $1\text{ m}^3 = 1\,000\,000\text{ cm}^3$

Similarly, this is equivalent to a  $1000\text{ mm} \times 1000\text{ mm} \times 1000\text{ mm}$  cube;

So,  $1\text{ m}^3 = 10^9\text{ mm}^3$

$\text{m}^3 \rightarrow \text{cm}^3$	$\times 1\,000\,000$	$\text{cm}^3 \rightarrow \text{m}^3$	$\div 1\,000\,000$
$\text{m}^3 \rightarrow \text{mm}^3$	$\times 10^9$	$\text{m}^3 \rightarrow \text{mm}^3$	$\div 10^9$



$6 \text{ m}^2 =$	$\text{cm}^2$
$0.002 \text{ m}^2 =$	$\text{mm}^2$
$24\,000 \text{ cm}^2 =$	$\text{m}^2$
$46\,000\,000 \text{ mm}^3 =$	$\text{m}^3$
$0.56 \text{ m}^3 =$	$\text{cm}^3$

$750 \text{ mm}^2 =$	$\text{m}^2$
$5 \times 10^{-4} \text{ cm}^3 =$	$\text{m}^3$
$8.3 \times 10^{-6} \text{ m}^3 =$	$\text{mm}^3$
$3.5 \times 10^2 \text{ m}^2 =$	$\text{cm}^2$
$152\,000 \text{ mm}^2 =$	$\text{m}^2$

Now use the technique shown on the previous page to work out the following conversions:

$31 \times 10^8 \text{ m}^2 =$	$\text{km}^2$
$59 \text{ cm}^2 =$	$\text{mm}^2$
$24 \text{ dm}^3 =$	$\text{cm}^3$
$4\,500 \text{ mm}^2 =$	$\text{cm}^2$
$5 \times 10^{-4} \text{ km}^3 =$	$\text{m}^3$

(Hint: There are 10 cm in 1 dm)

A 2.0 m long solid copper cylinder has a cross-sectional area of  $3.0 \times 10^2 \text{ mm}^2$ . What is its volume in  $\text{cm}^3$ ?

Volume = \_\_\_\_\_  $\text{cm}^3$

For the following, think about whether you should be writing a smaller or a larger number down to help decide whether you multiply or divide.

E.g. To convert  $5 \text{ m ms}^{-1}$  into  $\text{m s}^{-1}$  – you will travel more metres in 1 second than in 1 millisecond, therefore you should multiply by 1000 to get  $5000 \text{ m s}^{-1}$ .

$5 \text{ N cm}^{-2} =$	$\text{N m}^{-2}$
$1150 \text{ kg m}^{-3} =$	$\text{g cm}^{-3}$
$3.0 \text{ m s}^{-1} =$	$\text{km h}^{-1}$
$65 \text{ kN cm}^{-2} =$	$\text{N mm}^{-2}$
$7.86 \text{ g cm}^{-3} =$	$\text{kg m}^{-3}$

# 4. Rearranging Equations

Rearrange each equation into the subject shown in the middle column.

Equation		Rearrange Equation
$V = IR$	$R$	
$I = \frac{Q}{t}$	$t$	
$\rho = \frac{RA}{l}$	$A$	
$\varepsilon = V + Ir$	$r$	
$s = \frac{(u + v)}{2}t$	$u$	

Equation		Rearrange Equation
$hf = \phi + E_K$	$f$	
$E_P = mgh$	$g$	
$E = \frac{1}{2}Fe$	$F$	
$v^2 = u^2 + 2as$	$u$	
$T = 2\pi\sqrt{\frac{m}{k}}$	$m$	

Physics	<h1>5. Variables</h1>
Skills	

A variable is a quantity that takes place in an experiment. There are three types of variables:

Independent variable – *this is the quantity that you **change***

Dependent variable – *this is the quantity that you **measure***

Control variable – *this is a quantity that you **keep the same** so that it does not affect the results*

You can only have one independent variable and one dependent variable, but the more control variables you have the more accurate your results will be.

Further to these, you can also split the independent variable category – this can be continuous or discrete.

A continuous variable can take *any* numerical value, including decimals. You will construct line graphs for continuous variables.

A discrete variable can only take *specific* values or labels (e.g. integers or categories). You will construct bar charts for discrete variables.

*For each case study below, state the independent variable, dependent variable, and any control variables described. **Add further control variables**, and state what type the independent variable is and what type of graph you will present the results with (if required).*

Case study 1 – *Measuring the effect of gravity*

The aim of this experiment is to find out how fast objects of different masses take to fall from height. To conduct this experiment, we used a number of spheres of the same diameter, which had different masses. Each sphere had its mass measured on electronic scales, before being dropped from a marker exactly 2.000 m from the floor. The time the sphere took to drop was timed on a stopwatch and repeated 3 times for each sphere to gain an average time.

Independent variable: \_\_\_\_\_

Dependent variable: \_\_\_\_\_

Control variables: \_\_\_\_\_

\_\_\_\_\_

Type of independent variable: \_\_\_\_\_

Graph: \_\_\_\_\_

Case study 2 – The number of children involved in different after school activities.

The aim of this study is to discover which activities are most popular so the correct resources can be supplied to the correct member of staff. On a certain day after school the number of children were recorded for the different activities they took.

Independent variable: \_\_\_\_\_

Dependent variable: \_\_\_\_\_

Control variables: \_\_\_\_\_

Type of independent variable: \_\_\_\_\_

Graph: \_\_\_\_\_

Case study 3 – How far does the spring stretch?

The aim of this experiment is to find how far different masses stretch a spring. A spring was hung from a clamp stand, and its length end to end measured. A 10g mass was then added and the length of the spring measured and recorded. This was repeated adding 10g between 0g and 100g.

Independent variable: \_\_\_\_\_

Dependent variable: \_\_\_\_\_

Control variables: \_\_\_\_\_

Type of independent variable: \_\_\_\_\_

Graph: \_\_\_\_\_

Case study 4 - What is the best design for a turbine?

A wind turbine is connected to a voltmeter and is placed 1.0 m from a desk fan. The potential difference produced for different number of blades attached to the turbine is measured. The aim is to see what design produces the largest potential difference.

Independent variable: \_\_\_\_\_

Dependent variable: \_\_\_\_\_

Control variables: \_\_\_\_\_

Type of independent variable: \_\_\_\_\_

Graph: \_\_\_\_\_

Physics	<h1 style="margin: 0;">6. Constructing tables</h1>
Skills	

The **left-hand column** is for your **independent variable**.

The **right-hand column** is for your **dependent variable**. You may split this up into further columns if repeats are carried out, and make sure you include an average column. Each sub column must come under the main heading (including the average column).

Place results in the table in order of independent variable, usually starting with the smallest value first.

Ensure each column contains a heading with units in brackets. No units should be placed in the table.

All measured values in one column should be to the same decimal place – don't forget to add zeros if necessary!

Any averages should be given to the same number of decimal places as the measured values. Remember to remove any anomalies by circling the results and do not include them in calculating your average.

Any calculated values should be given to a suitable number of significant figures/ precision.

At AS/A Level we don't use brackets to separate the quantity heading from the units but use a / .

Example: **mass ( kg)** should be written as **mass / kg**.

**speed of car ( m/s)** should be written as **speed of car / m s<sup>-1</sup>**

Independent Variable Heading  /unit	Dependent Variable Heading  /unit			
	1	2	3	Average

A student forgot his exercise book when doing a practical on electrical resistance for a resistor. Below are his readings in the practical. He measured the current in the circuit three times for five different voltages. He has made many errors.

V : 0.11A, 0.1A, 0.12A  
 2.0V : 0.21A, 0.18A, 0.24

5V : 0.5, 5.1, 0.48      4.0V : 0.35A, 0.40A, 0.45

3.0V: 0.33A, 0.6  
 0.30

Construct a suitable table for his results.

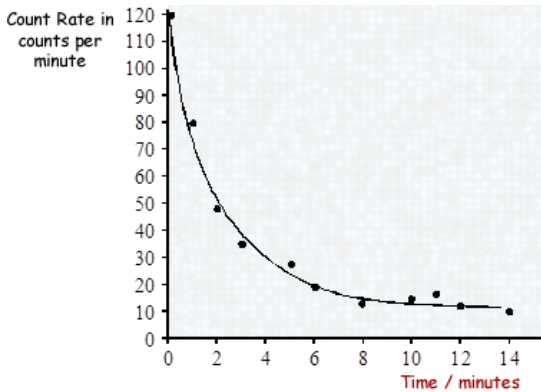
# 7. Drawing Lines of Best Fit

When drawing lines of best fit, draw a *smooth* straight or curved line that passes through the majority of the points. If you can, try to have an even number of points above and below the line if it can't go through all points.

When describing the trend, use the phrase....

“As ‘X’ increases, ‘Y’ *increases/decreases* in a *linear/non-linear* fashion.”

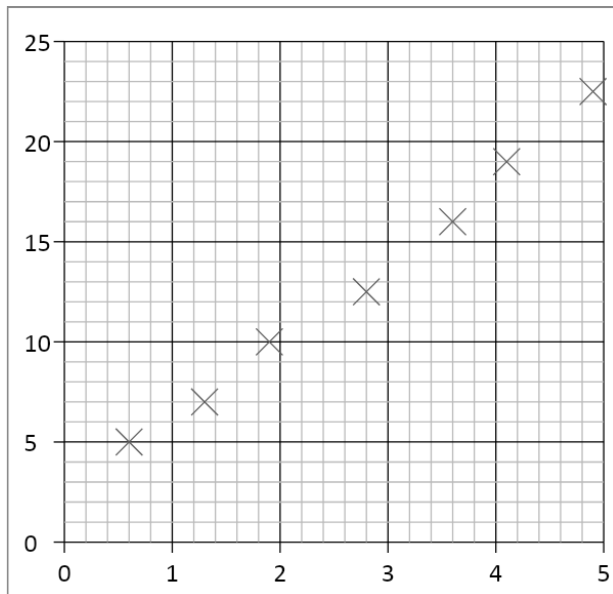
Substitute the quantities into X and Y, and choose either of the two options to describe the graph.



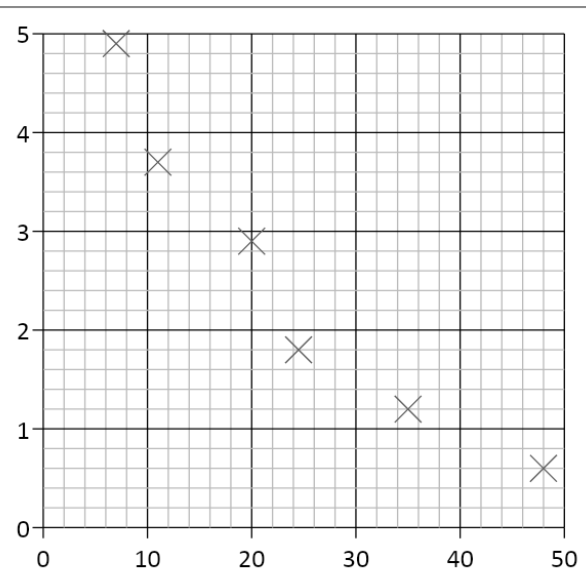
E.g.

As time increases, the count rate decreases in a non-linear fashion.

Draw a line of best fit for each of the graphs and describe the trend shown by each (call the quantities X and Y).

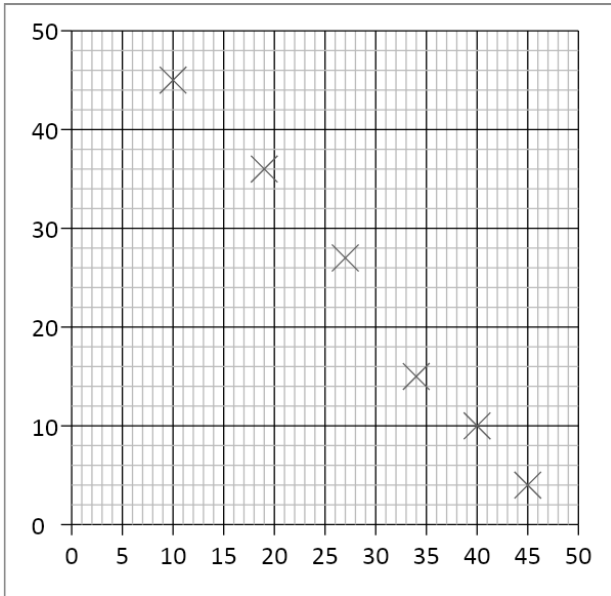


1.

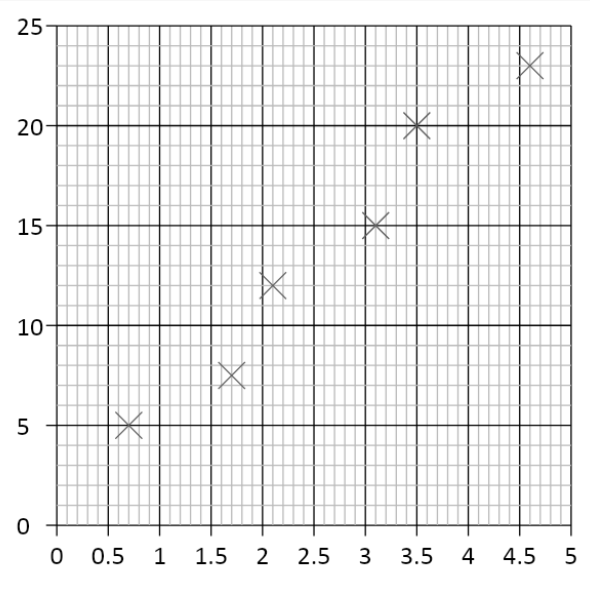


2.

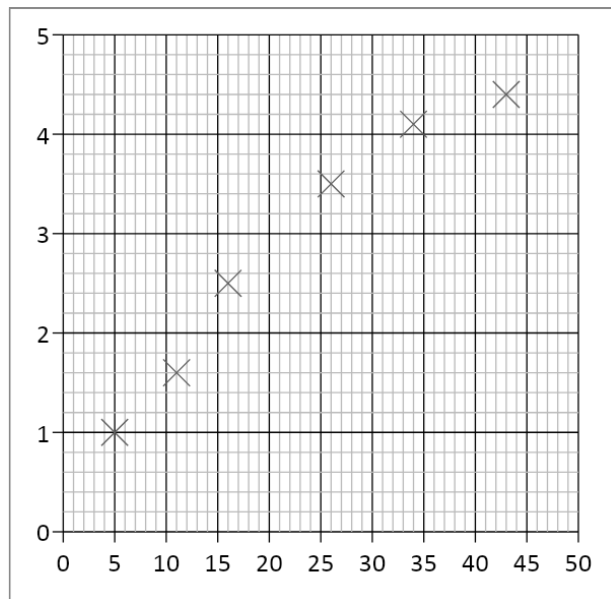




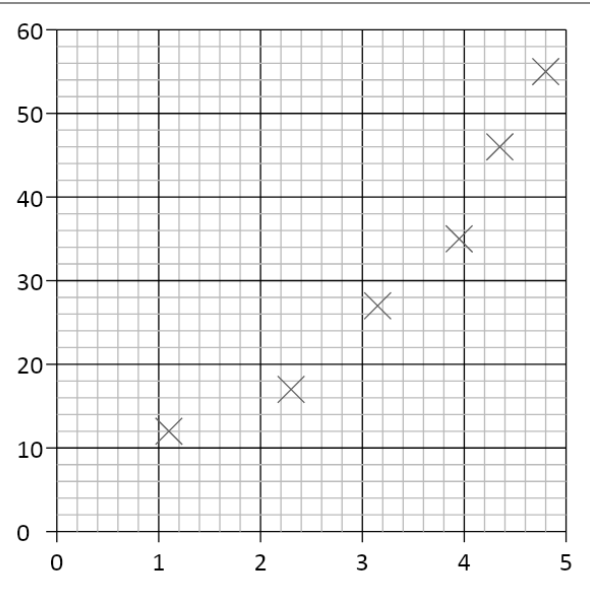
3.



4.



5.



6.

# 8. Calculating Gradients – Straight Lines

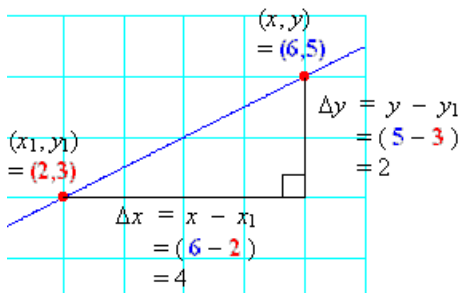
Gradients are a useful tool that show how fast or slow quantities change – e.g. speed tells us how fast distance is changing, or how quickly energy is being lost over time.

To calculate the gradient, pick any two points on the line as far away as possible and draw a large triangle between them.

The gradient is given by:

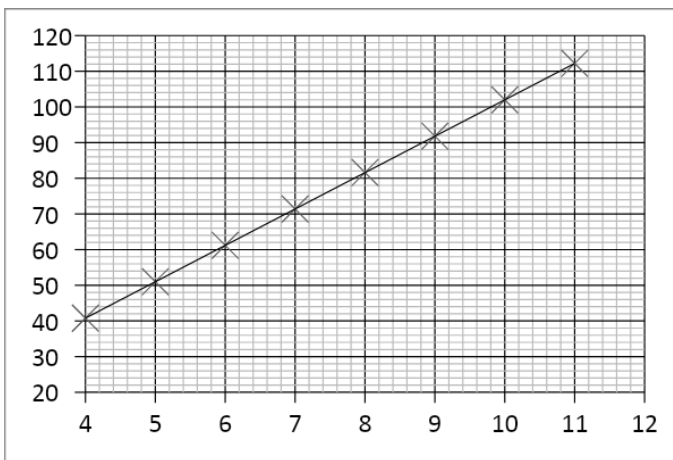
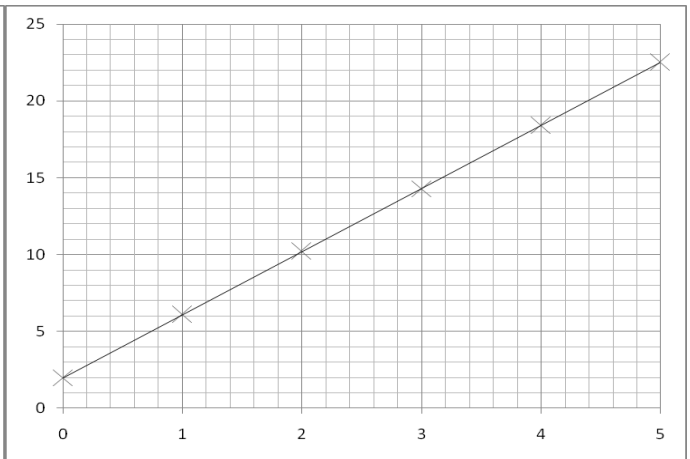
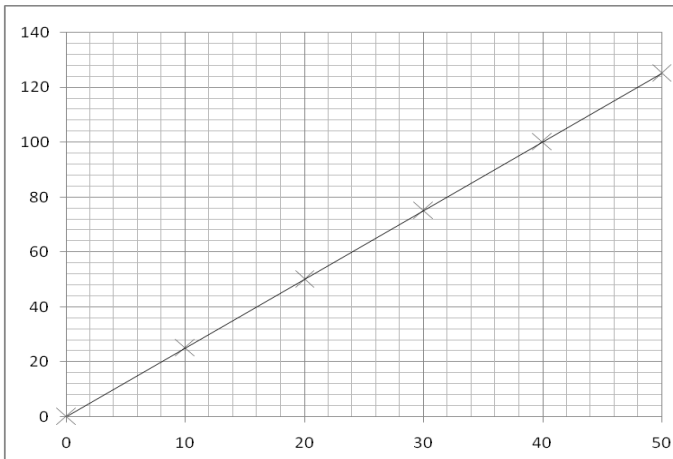
$$\text{gradient} = \frac{\text{difference in } y \text{ values}}{\text{difference in } x \text{ values}}$$

*But make sure the you subtract the values in the same order! Remember – if the line slopes up, the gradient should be positive; if the line slopes down, then the gradient should be negative.*



$$\begin{aligned} \text{Gradient} &= \frac{\text{difference in } y}{\text{difference in } x} \\ &= \frac{2}{4} \\ &= \underline{\underline{0.5}} \end{aligned}$$

Calculate the gradients of the graphs below



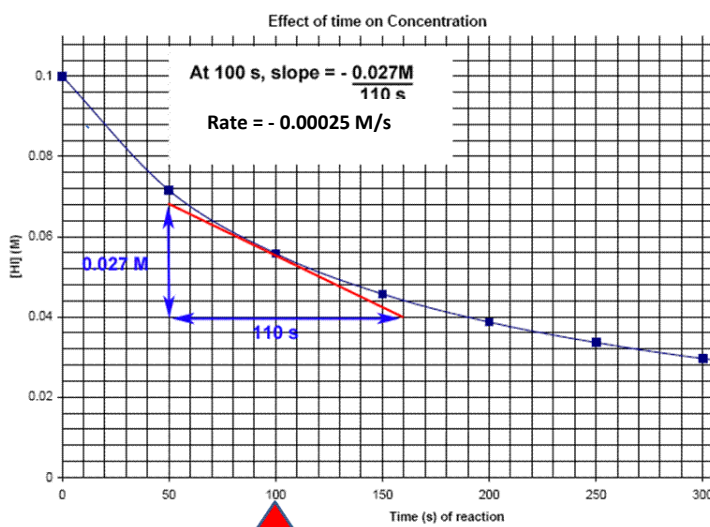
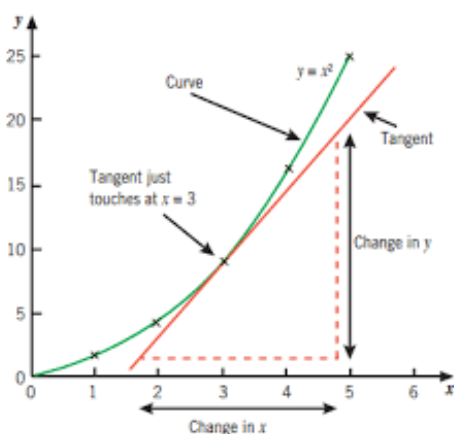
# 9. Calculating Gradients – Curved Lines

Most graphs in real life are not straight lines, but curves; however, it is still useful to know how the quantity changes over time, hence we still need to calculate gradients.

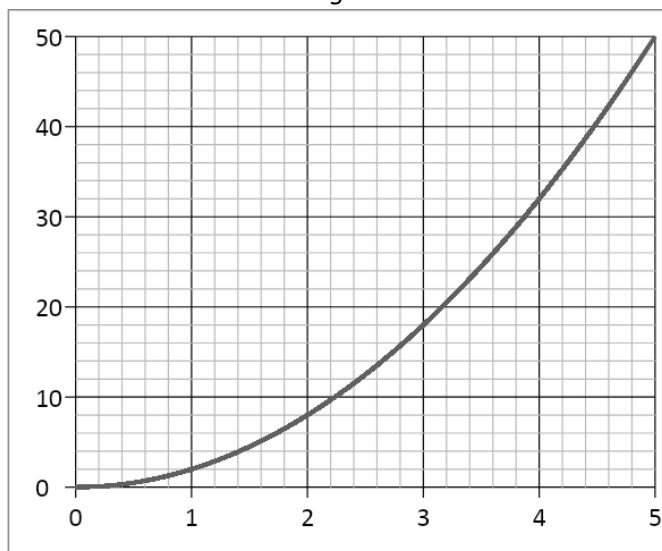
If we want to know the gradient at a particular point, firstly we need to draw a *tangent* to the curve at that point. A tangent is a straight line that follows the gradient at the required point. Once we have drawn the straight-line tangent, its gradient can be calculated in exactly the same way as the previous page showed.

Tip – make sure your tangents and gradient triangles are as big as possible to be as accurate as you can!

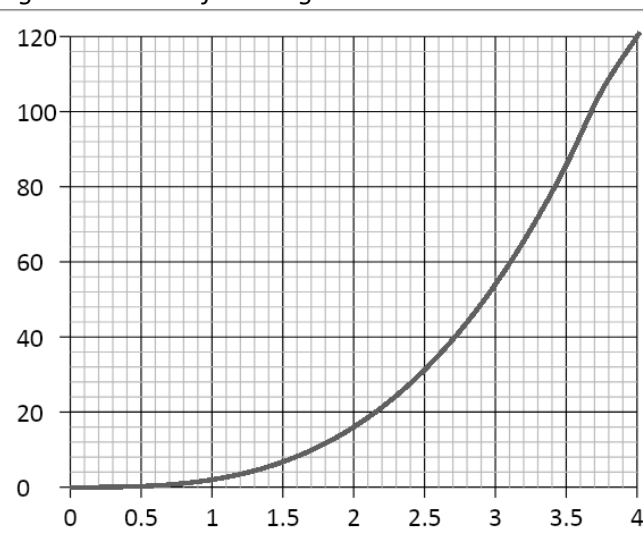
Examples of drawing tangents and calculating the gradient of a tangent:



Draw a tangent to the line and calculate its gradient at the following  $x$ -axis values:



2.0 and 4.0



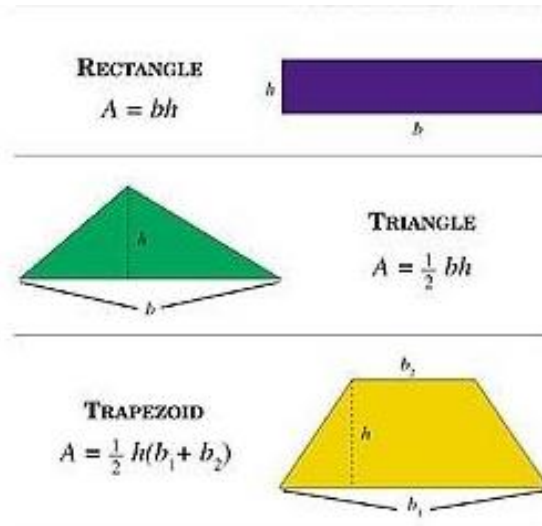
1.5 and 3.5

( Note - gradients in Physics often have units, this is something we will consider as we progress in the course)

# 10. Calculating Areas – Straight line Graphs

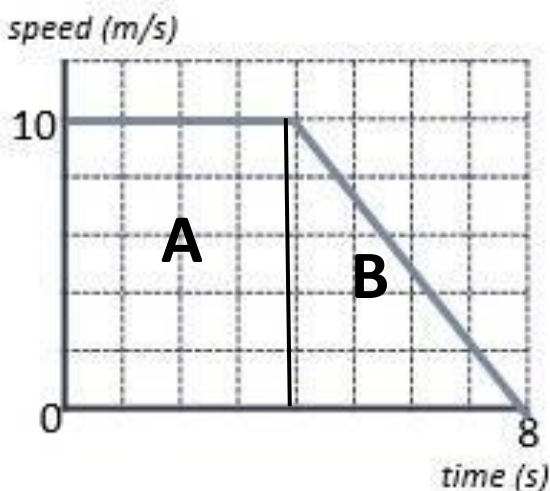
Often other quantities can be found by multiplying the two quantities represented on a graph together (for example, multiplying velocity and time gives distance travelled). The exact quantity can be found by calculating the area under the graph.

If the graph is made of straight lines, the total area can be found by splitting the graph into segments of rectangles and triangles (or into a trapezium) and adding those areas together.



*Important – the heights that you use should always be the perpendicular height from the base.*

Calculate the distance travelled by determining the area under the graph:



$$\text{Area A} = 10 \times 4 = 40 \text{ m}$$

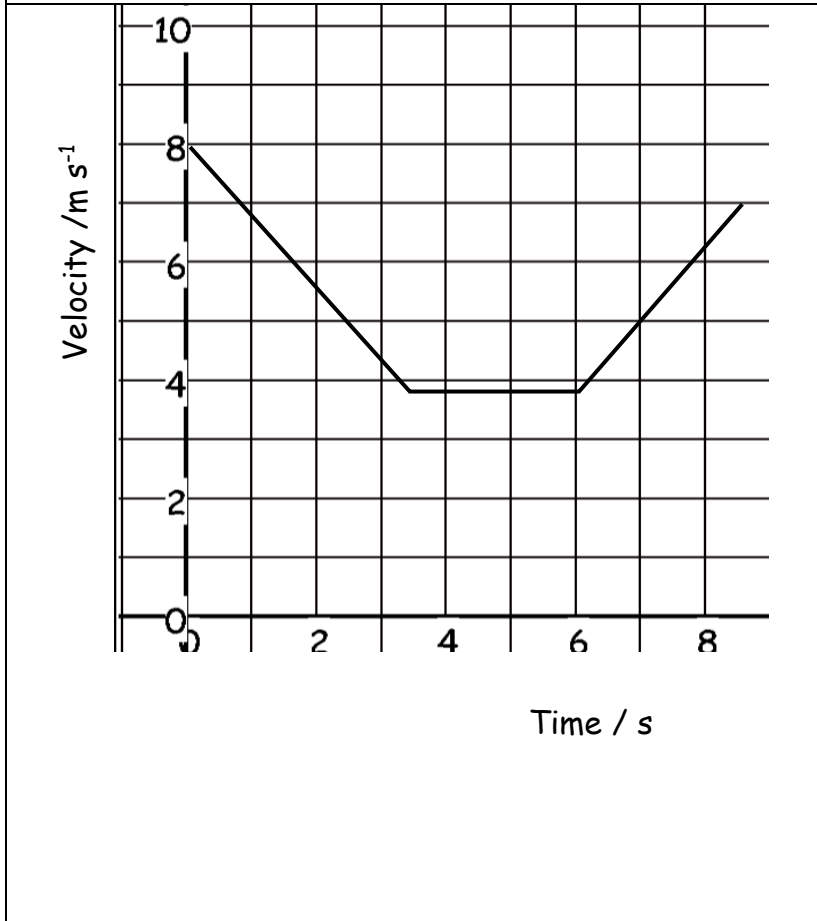
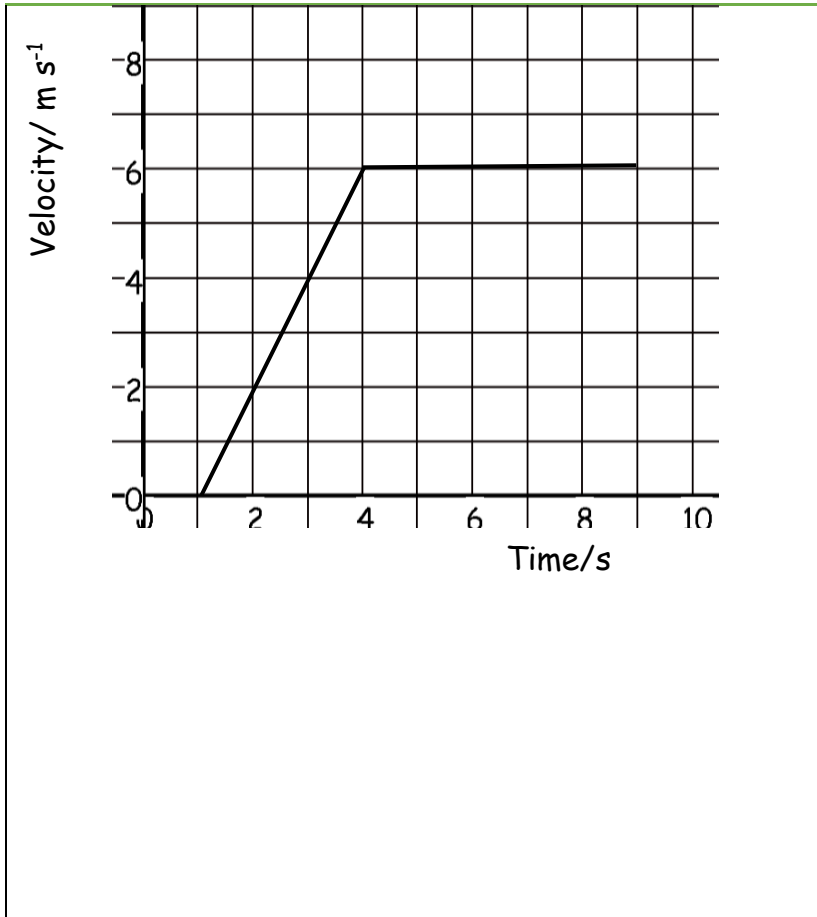
$$\text{Area B} = \frac{1}{2} \times 4 \times 10 = 20 \text{ m}$$

$$\text{Total Area} = A + B = 40 + 20 = \underline{\underline{60 \text{ m}}}$$

Or

$$\text{Area of trapezium} = \frac{1}{2} (4 + 8) \times 10 = \underline{\underline{60 \text{ m}}}$$

Calculate the area of the below graphs and the correct unit for that area.

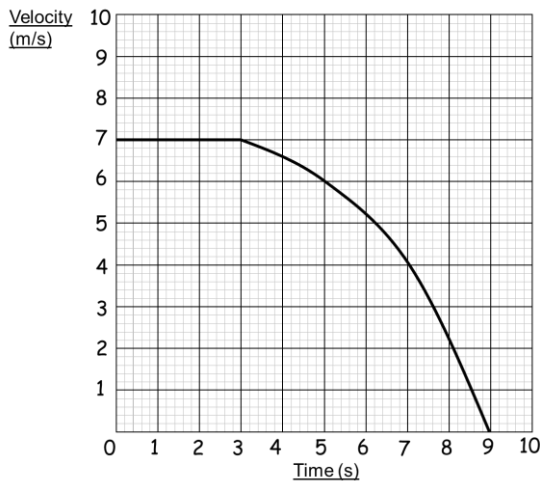


# 12. Calculating Areas – Curved line Graphs

When graphs have curved lines, we use a simple process of counting squares and estimating.

- 1) Calculate the area of 1 small (but the not smallest!) square on the graph
- 2) Count the number of whole squares under the line
- 3) Estimate the whole number of squares that have been segmented by the line.
- 4) Multiply the total number of squares by the area of one square to estimate the area.

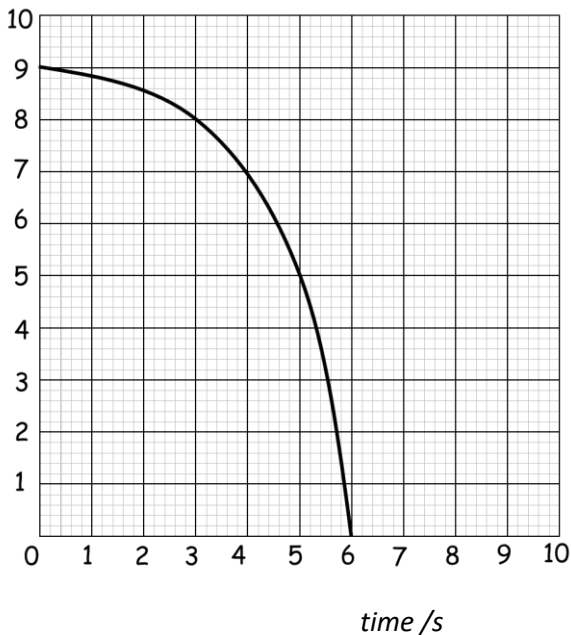
*E.g. Work out the distance travelled by calculating the area under the graph.*



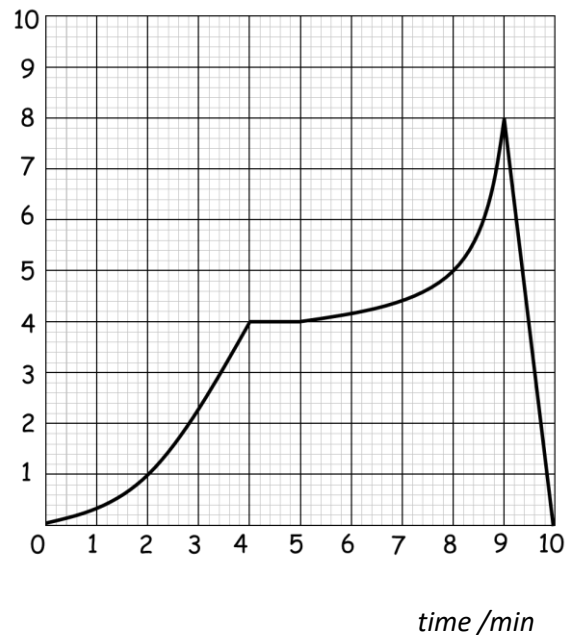
- 1) 1 square =  $1 \text{ m s}^{-1} \times 1 \text{ s} = 1 \text{ m}$
- 2) Whole Squares = 44
- 3) Segmented squares = 4
- 4) 48 squares  $\times 1 \text{ m} = \mathbf{48 \text{ m}}$

*Calculate the area under the following graphs.*

velocity/ $\text{m s}^{-1}$



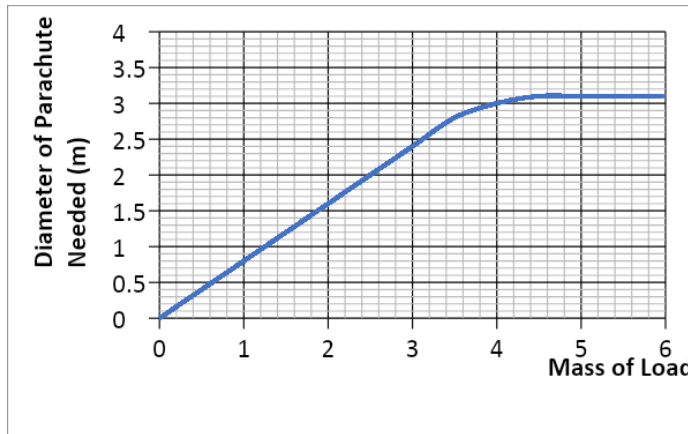
velocity/ $\text{km s}^{-1}$



# 13. Interpreting Graphs

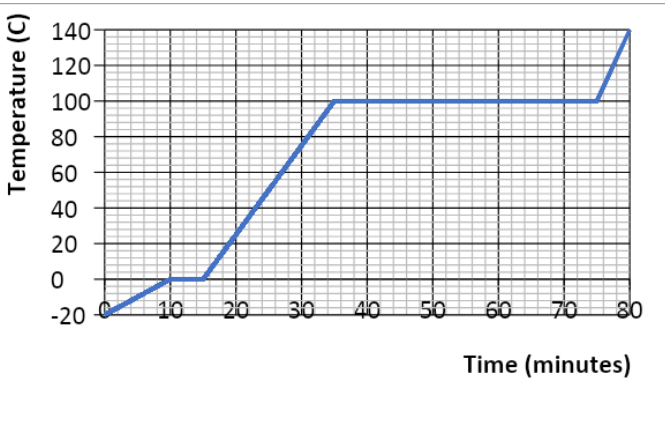
When interpreting graphs that are worth more than 2 marks, you need to go into more detail describing how the gradient changes over time and pick specific values to help support your answer.

- Tips:
- Use the quantities on the axes to support your answer.
  - Are there any points where the y value doesn't change? What is this value? When does this happen on the x axis?
  - Are there any maximum or minimum values? What are they? When do they occur?
  - The gradient increases/decreases at a constant/increasing/decreasing rate....
  - Does the gradient represent anything (e.g. velocity or acceleration)?
  - Are there multiple gradients? Are some steeper than others?



As the mass of the load increases, the diameter of the parachute needed also increases at a constant rate. This occurs to a mass of 3.4kg (which gives a diameter of 2.8m), where the gradient increases at a decreasing rate until the diameter remains constant at 3.1m for any load beyond 4.4kg.

Describe in detail each graph. Write your answer at the side of each graph. Include the points mentioned under 'tips' in your answers.




---



---



---



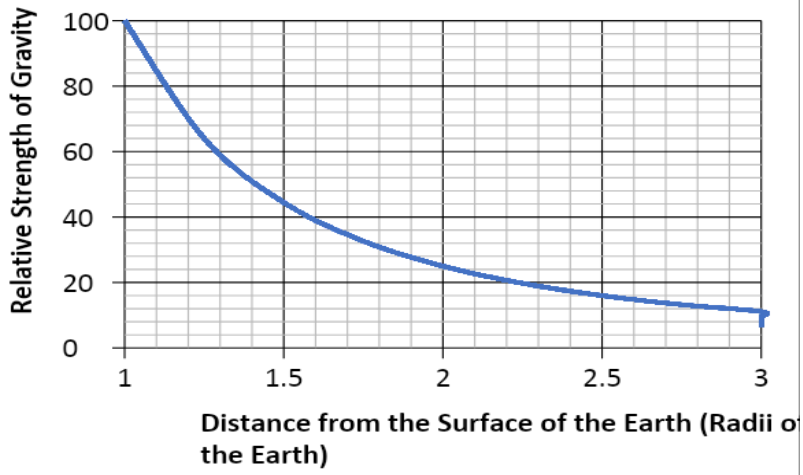
---



---



---




---

---

---

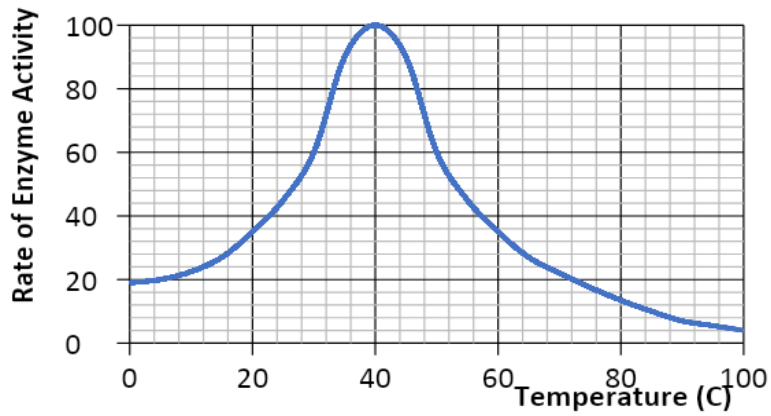
---

---

---

---

---




---

---

---

---

---

---

---

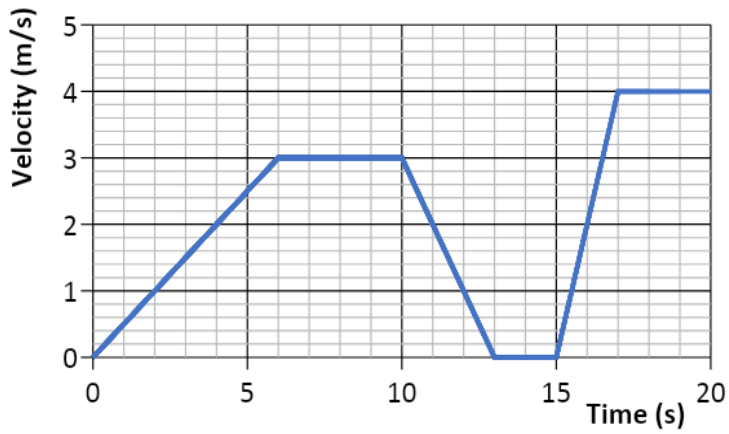
---

---

---

---

---




---

---

---

---

---

---

---

---

---

---

---

---

---



# 14. Accuracy, Precision, Resolution

An **accurate** result is one that is judged to be close to the true value. It is influenced by random and systematic errors.

The true value is the value that would be obtained in an ideal measurement.

A **precise** measurement is described when the values 'cluster' close together. We describe measurements as precise when repeated values are close together (consistent). It is influenced by random effects.

**Resolution** is the smallest change in the quantity being measured that causes a perceptible change in the output of the measuring device. This is usually the smallest measuring interval. It does not mean a value is accurate.

**Uncertainty** is variation in measured data and is due to random and systematic effects. We usually assume the uncertainty is the same as the resolution of the measuring instrument.

example ruler, resolution  $\pm 1$  mm so uncertainty is also  $\pm 1$  mm

Stopwatch used by a pupil, resolution  $\pm 0.01$  s but uncertainty estimated as  $\pm 0.2$  s due to human reaction time.

For our exam we estimate uncertainty and as long as you have a sensible justification your answer will be ok.

*E.g. The true temperature of the room is  $22.4$  °C. One thermometer gives a reading of  $22$  °C and another gives a reading of  $23.4$  °C. Which is most accurate and estimate its uncertainty?*

$23.4$  °C has the best resolution but is not close to the correct value.

$22$  °C has less resolution but is more accurate as it is closer to the correct result.

The uncertainty in this reading is  $22 \pm 1$  °C

Example

Isabelle is finding the mass of an insect, but the insect moves while on the electronic balance.

She records a set of readings as  $5.00$  mg,  $5.01$  mg,  $4.98$  mg,  $5.02$  mg.

The true value of the insect's mass is  $4.5$  mg.

Calculate an average value with estimated uncertainty for her results and compare this value with the true value using the terms above.

Physics	<h1>15. Identifying Errors</h1>
Skills	

There are two main types of error in Science:

- 1) Random error
- 2) Systematic error

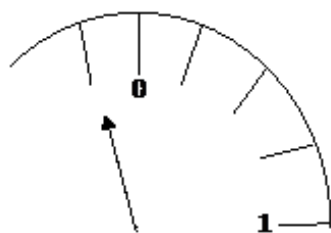
**Random errors** can be caused by changes in the environment that causes readings to alter slightly, measurements to be in between divisions on a scale or observations being perceived differently by other observers. These errors can vary in size and can give readings both smaller and larger than the true value.

The best way to reduce random error is to use as large values as possible (e.g. Large distances) and repeat and average readings, as well as taking precaution when carrying out the experiment.

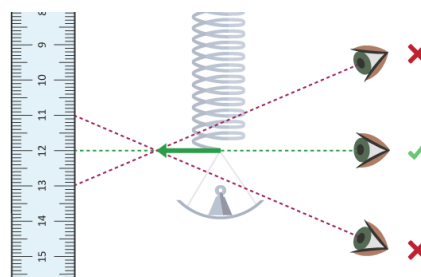
**Systematic errors** have occurred when all readings are shifted by the same amount away from the true value.

The two main types of systematic error are:

- i) *Zero error* – this is where the instrument does not read zero initially and therefore will always produce a shifted result (e.g. A mass balance that reads 0.01g before an object is placed on it). Always check instruments are zeroed before using.
- ii) *Parallax error* – this is where a measurement is not observed from eye level, so the measurement is always read at an angle producing an incorrect reading. Always read from eye level to avoid parallax.



*Zero Error*



*Parallax Error*

Repeating and averaging experiments will not reduce systematic errors when correct experimental procedure is not being followed.

There are occasions where readings are just measured incorrectly, or an odd result is far away from other readings – these results are called **anomalies**. Anomalies should be removed and repeated before used in any averaging.

For each of the measurements listed below identify the most likely source of error what type of error this is and one method of reducing it.

Measurement	Source of error	Type of error
A range of values are obtained for the length of a copper wire		
The reading for the current through a wire is 0.74 A higher for one group in the class		
A range of values are obtained for the rebound height of a ball dropped from the same start point onto the same surface.		
A few groups obtain different graphs of resistance vs light intensity for an LDR. A light bulb placed at different distances from the LDR was used to vary the light intensity.		

The time period (time of one oscillation) of a pendulum showing a range of values		

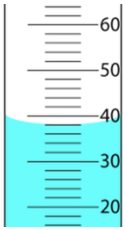
Physics	<h1>16. Improving Experiments – Accuracy, Resolution and Reliability</h1>
Skills	



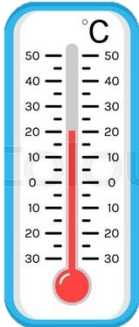
When improving **accuracy**, you must describe how to make sure your *method* obtains the best results possible. You should also try to *use as large quantities as possible as this reduces the percentage error in your results*. Also make your range as large as possible, with small intervals between each reading.

**Resolution** refers to the smallest scale division provided by your measuring instrument, or what is the smallest non-zero reading you can obtain from that instrument.

**Reliability** refers to how ‘trustworthy’ your results are. You can improve reliability by repeating and averaging your experiment, as well as removing anomalies.

Complete the table below to state how to use the measuring instruments as accurately as possible, as well as stating the precision (smallest scale division) of each instrument.

Measuring Instrument	Accuracy What procedures should you use to ensure you gain accurate results?	Resolution State the resolution of the instruments shown in the diagram.
Measuring Cylinder 		

<p>Top Pan Electronic (Mass) Balance</p> 		
<p><b>Measuring Instrument</b></p>	<p><b>Accuracy</b></p> <p>What procedures should you use to ensure you gain accurate results?</p>	<p><b>Precision</b></p> <p>State the precision of the instruments shown in the diagram.</p>
<p><b>Ruler</b></p> 		
<p><b>Thermometer</b></p> 		

Research and describe a method to determine the thickness of one sheet of A4 paper accurately. You may only use a mm ruler. You should also refer to the precision and reliability of your result.

---



---



---



---



---



---

## Task 2 – 5 hrs

It may be that you need to spend more time consolidating your maths skills using the transition task above and the CGP transition textbook. If (once you have completed a significant chunk of Task 1) you feel like this is the case for you, please do let me know and we can discuss it.

However, there is a research task in Physics A Level and it is important that you practice both delving further into interesting areas of physics (whether historical, established or cutting edge) and taking notes.

Using the Cornell notes system: <http://coe.jmu.edu/learningtoolbox/cornellnotes.html> make 1 page of notes **from each site** covering a topic of your choice.

- a) <http://home.cern/about>

CERN encompasses the Large Hadron Collider (LHC) and is the largest collaborative science experiment ever undertaken. Find out about it here and make a page of suitable notes on the accelerator

- b) [https://www.joshworth.com/dev/pixelspace/pixelspace\\_solarsystem.html](https://www.joshworth.com/dev/pixelspace/pixelspace_solarsystem.html)

The solar system is massive, and its scale is hard to comprehend. Have a look at this award-winning website and make a page of suitable notes

- c) <https://phet.colorado.edu/en/simulations/category/physics>

PHET create incredibly useful online simulations which you will undoubtedly have seen during physics GCSE lessons. Find the resistance of a wire simulation and conduct a simple experiment. Make a one-page summary of the experiment and your findings. Then spend as long as you like looking at the rest of these 😊

- d) <http://climate.nasa.gov>

NASA's Jet Propulsion Laboratory has a great deal of information on climate change, and engineering solutions to combat it. Have a look and make notes on an article of your choice.

- e) <http://www.livescience.com/46558-laws-of-motion.html>

Newton's Laws of Motion are fundamental laws for the motions of all of the objects we can see around us. Use this website and the suggested further reading links below to make your own page of notes on the topic.

**E-mail me a photograph of each page of notes as soon as you have completed the task, and at the latest by the 28<sup>th</sup> August deadline.**

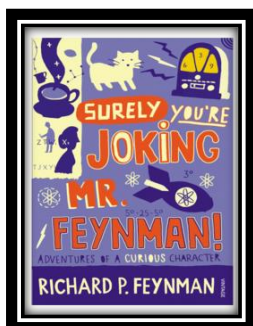
**You also need to bring this work in to school ready for the first physics lesson of the year.**

[alex.west@northoxfordshire-academy.org](mailto:alex.west@northoxfordshire-academy.org)

## Extended Reading List – spend at least 5 hrs during the summer reading or watching

Optional reading - below is a selection of books that should appeal to a physicist – someone with an enquiring mind who wants to understand the universe around us. None of the selections are textbooks full of equations (there will be plenty of time for that!) but each one provides insight to either an application of physics or a new area of study that you will meet at A Level.

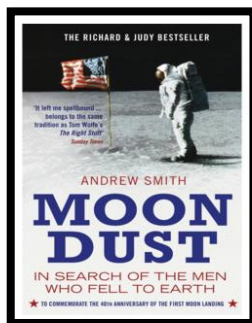
### 1) Surely You're Joking Mr Feynman: Adventures of a Curious Character



ISBN - 009917331X - Richard Feynman isn't a household name (unless your house contains a physicist) but he was a brilliant, inspirational man. By reading this book you will get an insight into his life's work, including the creation of the first atomic bomb, his bongo playing(!) and his ground-breaking work in the field of particle physics.

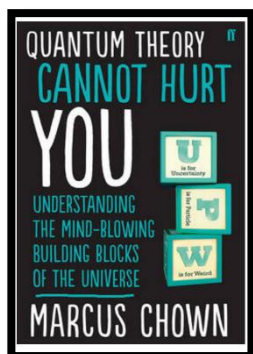
(Also available on Audio book).

### 2) Moon dust: In Search of the Men Who Fell to Earth

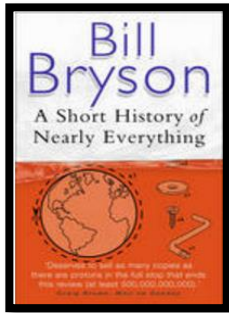


ISBN – 1408802384 - One of the greatest scientific achievements of all time was putting mankind on the surface of the moon. Only 12 men made the trip to the surface; at the time of writing, only 9 are still with us. The book uses the personal accounts of astronauts and others involved in the space programme. Hopefully, a new era of space flight is about to begin as we push on to put mankind on Mars within the next few decades.

### 3) Quantum Theory Cannot Hurt You: Understanding the Mind-Blowing Building Blocks of the Universe



ISBN - 057131502X - Any Physics book by Marcus Chown is an excellent insight into some of the more exotic areas of Physics, without the need for any prior knowledge. In your first year of A-Level study you will encounter the quantum world for the first time. This book will provide you with interesting facts and handy analogies to whip out to impress your peers!



#### 4) A Short History of Nearly Everything

ISBN – 0552997048 - A modern classic and popular science writing at its best. This is Bill Bryson's quest to find out everything that has happened from the Big Bang to the rise of civilisation - how we got from there, being nothing at all, to here, being us.

### Film / Video Clip List

Hopefully you'll get the opportunity to soak up some electromagnetic radiation from our nearest star over the summer – synthesising some important Vitamin D – but if you do get a few rainy days where you're stuck indoors, here are some ideas for films to watch or clips to find online.

#### Science Fiction Films

1. Arrival (2016)
2. Gravity (2013)
3. Interstellar (2014)
4. The Imitation Game (2015)
5. The Prestige (2006)
6. Ready Player One (2018)
7. The Host (2013)

#### Online Clips / Series

1. **Minute Physics** – A variety of Physics questions explained simply (in felt tip) in a couple of minutes. <https://www.youtube.com/user/minutephysics>
2. **Wonders of the Universe / Wonders of the Solar System** – both have been available on Netflix so hopefully still are – Brian Cox explains the Cosmos using some excellent analogies and wonderful imagery.
3. **Shock and Awe, The Story of Electricity** – Professor Jim Al-Kalili presents a 3-part BBC documentary. Essential viewing if you want to see how our lives have been transformed by the ideas of a few great scientists a little over 100 years ago. The link below takes you to a stream of all three parts joined together, but it is best watched in hourly instalments (alternatively watch any Horizon documentary – loads of choice on Netflix and the I-Player). <https://www.youtube.com/watch?v=Gtp51eZkwol>
4. **NASA TV** – Online coverage of launches, missions, testing and the ISS. Plenty of clips and links to explore to find out more about applications of Physics in Space technology. <http://www.nasa.gov/multimedia/nasatv/>
5. **Greatest Minds of all Time: Richard Feynman** – See the life's work of the “great explainer”, an incredible scientist, lecturer and bongo player (!) who created mischief and enlightenment in all areas of modern Physics. <https://www.youtube.com/watch?v=cNaEI70hT-o>